REMARKS

In the last Office Action, the Examiner rejected claims 1 and 39-46 under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 4,384,232 to Debely. Claims 10, 27 and 47-60 were allowed by the Examiner.

Applicant and applicant's counsel note with appreciation the indication of allowable subject matter concerning claims 10, 27 and 47-60. However, for the reasons noted below, applicant respectfully submits that claims 1 and 39-46 also patentably distinguish from the prior art of record. Claims 2-9, 11-26 and 28-38 have been canceled.

In accordance with the present response, allowed independent claim 10 has been amended only to correct an inadvertent informality in the preamble resulting from the amendment to claim 10 submitted in the response filed September 11, 2003. More specifically, the preamble of claim 10 has been amended herein only to change "the quartz crystal tuning form" to "the quartz crystal tuning fork resonator."

The amendment to allowed claim 10 made herein does not raise new issues requiring further search and/or consideration. Instead, the preamble of allowed claim 10 has been amended only to correct an inadvertency resulting from the amendment to claim 10 submitted in the

response filed September 11, 2003, thereby placing the application in condition for allowance or in better form for appeal.

Applicant respectfully requests reconsideration of his application in light of the following discussion.

Brief Summary of the Invention

The present invention is directed to quartz crystal tuning fork resonator for undergoing vibration in a flexural mode.

Quartz crystal tuning fork resonators which vibrate in a flexural mode are widely used as a time standard in communication equipment such as wristwatches, cellular phones, and pagers. Due to miniaturization and light weight requirements for these products, such quartz crystal tuning fork resonators must be small with a low series resistance and a high quality factor. However, it has not been possible to miniaturize the conventional quartz crystal tuning fork resonators while achieving a small series resistance and a high quality factor. This is due to the fact that the conventional quartz crystal tuning fork resonators has a small electro-mechanical transformation efficiency which generates a small electric field.

The present invention overcomes the drawbacks of the conventional art. Figs. 1-3 show an embodiment of a quartz crystal tuning fork resonator 1 according to the present invention embodied in the claims capable of vibrating in a flexural mode. The quartz crystal tuning fork resonator 1 has quartz crystal tuning fork tines 2, 3 for undergoing vibration in an inverse phase. Each of the quartz crystal tuning fork tines 2, 3 has a first main surface and a second main surface opposite the first main surface, each of the first and second main surfaces having a central linear portion. The quartz crystal tuning fork tines 2, 3 extend from a quartz crystal tuning fork base 4. At least one groove (5, 6, 11, 12) is formed in the central linear portion of each of the first and second main surfaces of each of the quartz crystal tuning fork tines 2, 3. A width $\underline{W}_2$ of the groove in the central linear portion of one of the first and second main surfaces of each of the quartz crystal tuning fork tines 2, 3 is greater than or equal to a distance $\underline{W}_1$ or $\underline{W}_3$ in the width direction of the groove measured from an outer edge of the groove to an outer edge of the tuning fork tine.

In another embodiment shown in Figs. 15-17, a quartz crystal tuning fork resonator 300 capable of vibrating in a flexural mode has a quartz crystal tuning fork base 303 and quartz crystal tuning fork tines 301, 302 extending from the quartz crystal tuning fork base 303. Each of the quartz

crystal tuning fork tines 301, 302 has stepped portions 304, 307 and 305, 314, respectively. At least one first electrode (308, 315) is disposed on each of two of the stepped portions of each of the quartz crystal tuning fork tines 301, 302. At least one second electrode (312, 319) is disposed on a side of each of the quartz crystal tuning fork tines 301, 302. The second electrode of each of the quartz crystal tuning fork tines 301, 302 has an electrical polarity opposite to an electrical polarity of the first electrode of each of the quartz crystal tuning fork tines 301, 302.

By the foregoing construction, the electro-mechanical transformation efficiency of the quartz crystal tuning fork resonators according to the present invention becomes large, thereby enabling the quartz crystal tuning fork resonator to be miniaturized while achieving a low series resistance and a high quality factor.

Traversal of Prior Art Rejection

Claims 1 and 39-46 were rejected under 35 U.S.C. §102(b) as being anticipated by Debely. Applicant respectfully traverses this rejection and submits that independent claim 1 and dependent claims 39-46 recite subject matter which is not identically disclosed or described in Debely.

Independent claim 1 is directed to a quartz crystal tuning fork resonator capable of vibrating in a flexural mode and requires a plurality of quartz crystal tuning fork tines for undergoing vibration in an inverse phase, each of the quartz crystal tuning fork tines having a first main surface and a second main surface opposite the first main surface, each of the first and second main surfaces having a central linear portion. Claim 1 further requires a quartz crystal tuning fork base to which the quartz crystal tuning fork tines are attached, and at least one groove formed in the central linear portion of each of the first and second main surfaces of each of the quartz crystal tuning fork tines. Claim 1 further requires that a width of the groove in the central linear portion of one of the first and second main surfaces of each of the quartz crystal tuning fork tines is greater than or equal to a distance in the width direction of the groove measured from an outer edge of the groove to an outer edge of the tuning fork tine. No corresponding structural combination is disclosed or described by Debely.

Debely discloses a piezoelectric resonator. In the embodiments shown in Figs. 1-4, the piezoelectric resonator has the form of a tuning fork with a central gap separating two parallel tines 2, 3. Two longitudinal grooves 4, 5 are cut in a surface of each tine in a symmetrical relation relative to a central linear portion of the tine (i.e., the

grooves 4, 5 are <u>not</u> formed in the central linear portion of the tine surface). In another embodiment shown in Fig. 6, the piezoelectric resonator has two parallel tines 33, 34 having respective grooves 35-38 cut in central linear portions of respective opposed main surfaces of the tines 33, 34.

However, Debely does not disclose or describe the structural combination of (1) <u>at least one groove formed in the central linear portion of each of the first and second main surfaces of each of the quartz crystal tuning fork tines</u> and (2) <u>a width of the groove in the central linear portion of one of the first and second main surfaces of each of the quartz crystal tuning fork tines is greater than or equal to a distance in the width direction of the groove measured from an outer edge of the groove to an outer edge of the tuning fork tine</u>, as required by independent claim 1. More specifically, in the piezoelectric resonators shown in Figs. 1-4 of Debely, the grooves 4, 5 are clearly <u>not</u> formed in <u>the central linear portion</u> of each of the first and second main surfaces of each of the tines, as recited in independent claim 1. Likewise, with respect to Figs. 1-4, there is no written description in Debely of the foregoing specific dimensional relationship between the width of each of the grooves and the distance in the width direction of the groove measured from an outer edge of the groove to an outer edge of the tine required by claim 1. Furthermore, each of the enlarged views in Figs. 3 and 4

of Debely show that the width of each of the grooves is actually <u>smaller</u> (i.e., not greater or equal to) than a distance in the width direction of the groove measured from an outer edge of the groove to an outer edge of the tine.

With respect to the piezoelectric resonator shown in Fig. 6 of Debely, the Examiner contends that Debely discloses that a width of each of the grooves 35-38 in the central linear portion of one of the first and second main surfaces of each of the tines is greater than or equal to a distance in the width direction of the groove measured from an outer edge of the groove to an outer edge of the tuning fork tine, as required by independent claim 1. Applicant respectfully disagrees with the Examiner's contention.

While disclosing that each of the grooves 34-38 in Fig. 6 is formed in the central linear portion of respective main surfaces of the tines, Debely clearly does <u>not</u> disclose or describe that a width of the groove in the central linear portion of one of the first and second main surfaces of each of the tines is <u>greater than or equal to</u> a distance in the width direction of the groove measured from an outer edge of the groove to an outer edge of the tuning fork tine, as required by independent claim 1. There is no written description in Debely of the foregoing specific dimensional relationship between the width of each of the grooves and the distance in the width direction of the groove measured from an

outer edge of the groove to an outer edge of the tine. Furthermore, in Fig. 6 of Debely, the width of each of the grooves 35-38 is actually smaller (i.e., not greater or equal to) than a distance in the width direction of the groove measured from an outer edge of the groove to an outer edge of the tine.

Thus the piezoelectric resonators disclosed by Debely do not enjoy the benefits of the foregoing structural features recited in claim 1 but not disclosed in Debely. More specifically, according to the resonator embodied in independent claim 1, by providing at least one groove in the central linear portion of each of the first and second main surfaces of each of the quartz crystal tuning fork tines, the quartz crystal tuning fork resonator has a small series resistance and a high quality factor even when it is miniaturized since the moment of inertia of the quartz crystal tuning fork tines becomes large. Furthermore, the moment of inertia of the quartz crystal tuning fork tines is further increased due to the foregoing relationship between the width of the groove and the distance in the width direction of the groove measured from an outer edge of the groove to an outer edge of the tuning fork tine recited in claim 1.

In the absence of the foregoing disclosure recited in independent claim 1, anticipation cannot be found. See, e.g., W.L. Gore & Associates v. Garlock, Inc., 220 USPQ 303,

313 (Fed. Cir. 1983), cert. denied, 469 U.S. 851 (1984) ("Anticipation requires the disclosure in a single prior art reference of each element of the claim under consideration"); Continental Can Co. USA v. Monsanto Co., 20 USPQ2d 1746, 1748 (Fed. Cir. 1991) ("When more than one reference is required to establish unpatentability of the claimed invention anticipation under § 102 can not be found".); Lindemann Maschinenfabrik GmbH v. American Hoist & Derrick Co., 221 USPQ 481, 485 (Fed. Cir. 1984) (emphasis added) ("Anticipation requires the presence in a single prior art reference disclosure of each and every element of the claimed invention, arranged as in the claim").

Stated otherwise, there must be no difference between the claimed invention and the reference disclosure, as viewed by a person of ordinary skill in the field of the invention. This standard is clearly not satisfied by Debely for the reasons stated above. Furthermore, Debely does not suggest the claimed subject matter and, therefore, would not have motivated one skilled in the art to modify Debely's piezoelectric resonator to arrive at the claimed invention.

Claims 39-46 depend on and contain all of the limitations of independent claim 1 and, therefore, distinguish from the reference at least in the same manner as claim 1.

In view of the foregoing, applicant respectfully requests that the rejection of claims 1 and 39-46 under 35 U.S.C. §102(b) as being anticipated by Debely be withdrawn.

The amendment to allowed claim 10 made herein does not raise new issues requiring further search and/or consideration. Instead, the preamble of allowed claim 10 has been amended only to correct an inadvertency resulting from the amendment to claim 10 submitted in the response filed September 11, 2003, thereby placing the application in condition for allowance or in better form for appeal.

In view of the foregoing amendments and discussion, the application is believed to be in allowable form. Accordingly, favorable reconsideration and allowance of the claims are most respectfully requested.

Respectfully submitted,

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